

Logical Agents

Chapter 7



NORTH-WEST UNIVERSITY
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INSTITUTIONAL OFFICE

Announcements

- Class test 2
 - Thursday, 11 November 2021
 - Chapters 8 and 9
- Practical Assignment 3 uploaded

Overview of lecture

- Forward and backward chaining



Forward and backward chaining

- Full power of resolution not always needed
- Real world knowledge bases contain Horn clauses
- Horn clause is disjunction of literals of which at most one is positive

$Shoot \vee \neg WumpusAlive \vee \neg WumpusAhead$

$\neg Shoot \vee \neg WumpusAlive \vee \neg WumpusAhead$

Forward and backward chaining

- Each Horn clause written as implication

$$\textit{Shoot} \vee \neg \textit{WumpusAlive} \vee \neg \textit{WumpusAhead}$$

$$\textit{WumpusAlive} \wedge \textit{WumpusAhead} \Rightarrow \textit{Shoot}$$

- A horn clause with **exactly one** positive literal is called a **definitive clause**

Forward and backward chaining

$Shoot \vee \neg WumpusAlive \vee \neg WumpusAhead$

Head

Body

$WumpusAlive \wedge WumpusAhead \Rightarrow Shoot$

Body

Head

Forward and backward chaining

WumpusAlive

True \Rightarrow WumpusAlive

Fact

$$\neg W_{1,1} \vee \neg W_{1,2}$$

$$W_{1,1} \wedge W_{1,2} \Rightarrow \textit{False}$$

Goal clause

Forward and backward chaining

Horn Clauses									
Definitive clause									
	A	B	C	D	!A	!B	!C	!A V !B V !C V D	A ^ B ^ C ==> D
	0	0	0	0	1	1	1	1	1
	0	0	0	1	1	1	0	1	1
	0	0	1	0	1	1	1	1	1
	0	0	1	1	1	1	0	1	1
	0	1	0	0	1	0	1	1	1
	0	1	0	1	1	0	0	1	1
	0	1	1	0	1	0	1	1	1
	0	1	1	1	1	0	0	1	1
	1	0	0	0	0	1	1	1	1
	1	0	0	1	0	1	0	1	1
	1	0	1	0	0	1	1	1	1
	1	0	1	1	0	1	0	1	1
	1	1	0	0	0	0	1	1	1
	1	1	0	1	0	0	0	1	1
	1	1	1	0	0	0	1	0	0
	1	1	1	1	0	0	0	1	1
Goal Clause									
	A	B	!A	!B	!A V !B	A ^ B ==>False			
	0	0	1	1	1	1			
	0	1	1	0	1	1			
	1	0	0	1	1	1			
	1	1	0	0	0	0			
Fact									
	A	True ==> A							
	0	0							
	1	1							

Forward and backward chaining

- Inference with Horn clauses performed by forward and backward chaining
- Decision if sentences follow logically from knowledge bases is linear in the size of the knowledge base

Forward chaining

- Determine if single propositional symbol Q follows logically from knowledge base of Horn clauses
- Start with known facts in the knowledge base
- If all conditions of implication is known then consequence can be added to the knowledge base

Forward chaining

- Process continues until Q is added or no further conclusions can be made
- An example of data driven reasoning

Forward chaining

- Forward chaining is sound and complete for Horn clauses

$$P \Rightarrow Q$$

$$L \wedge M \Rightarrow P$$

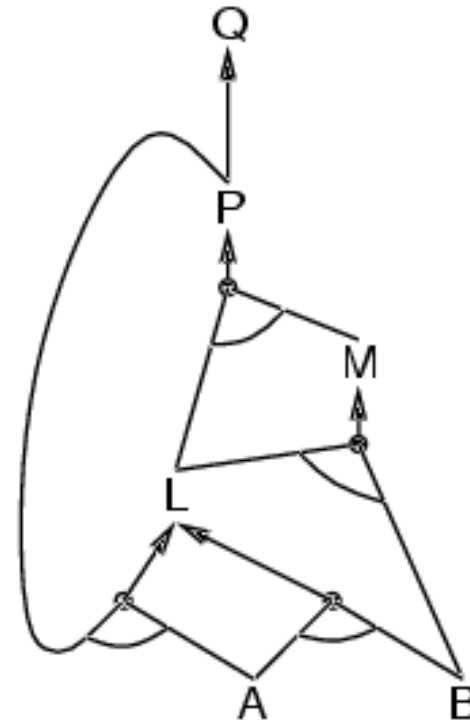
$$B \wedge L \Rightarrow M$$

$$A \wedge P \Rightarrow L$$

$$A \wedge B \Rightarrow L$$

A

B



Forward chaining

$$P \Rightarrow Q$$

$$L \wedge M \Rightarrow P$$

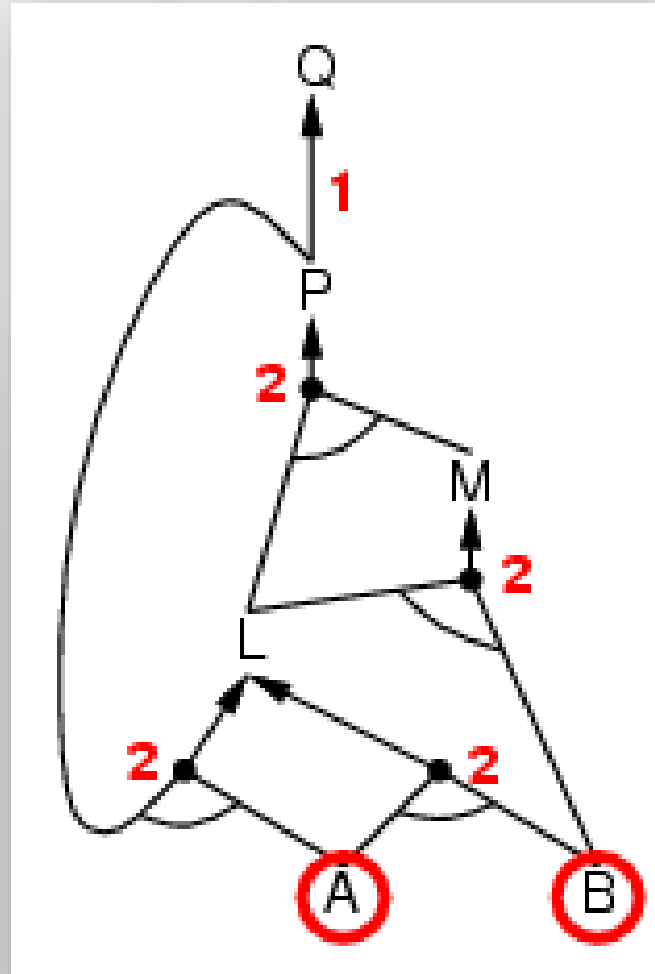
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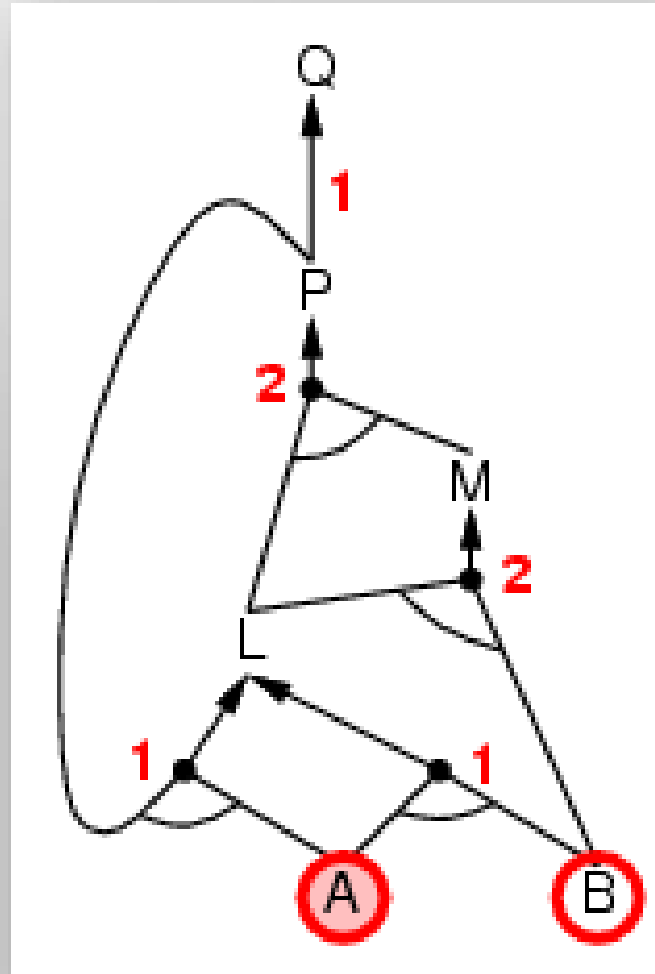
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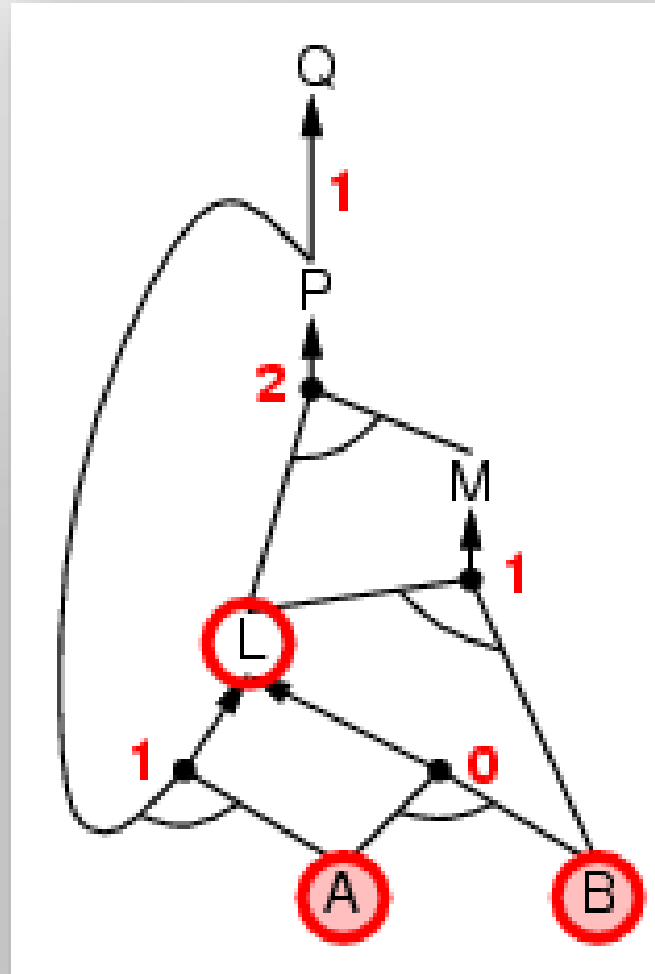
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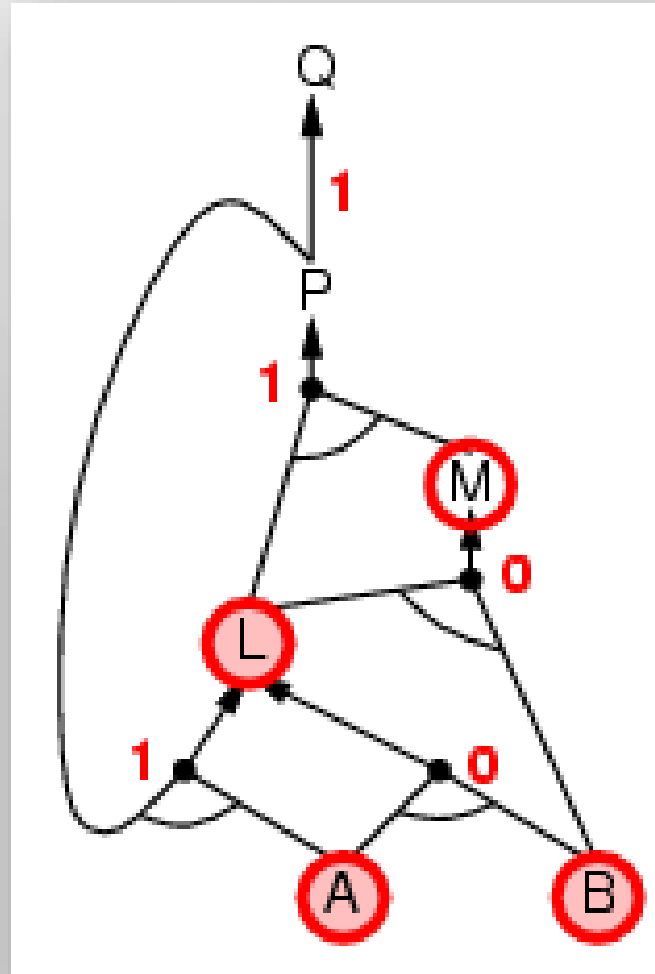
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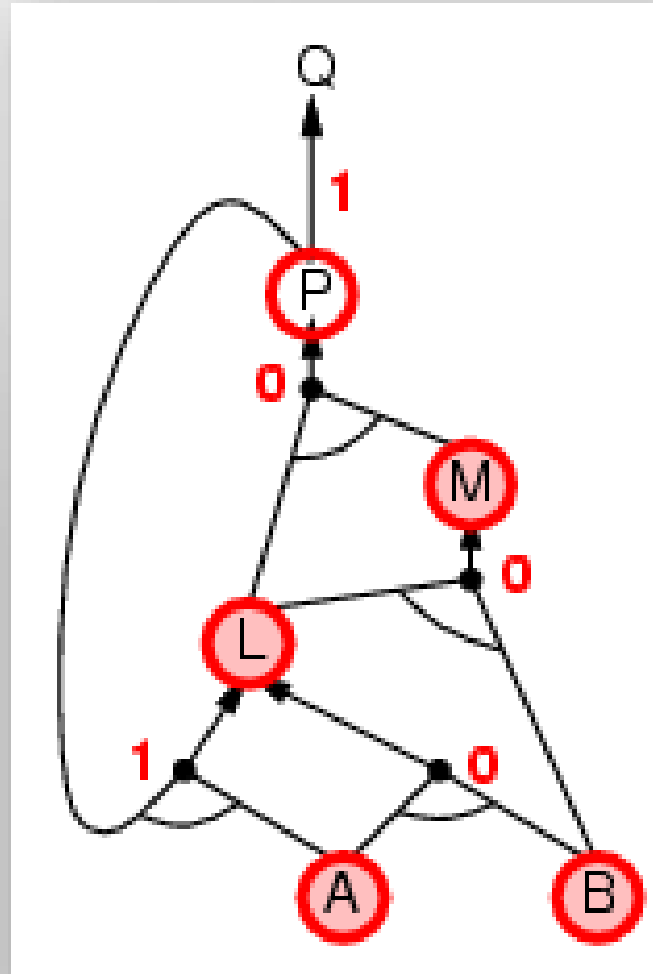
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Forward chaining

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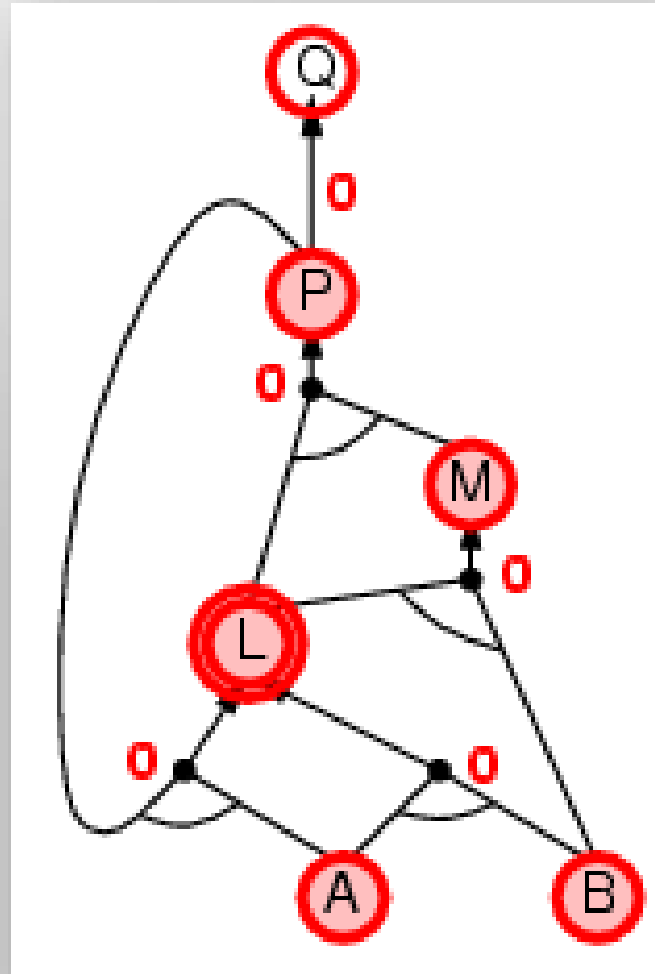
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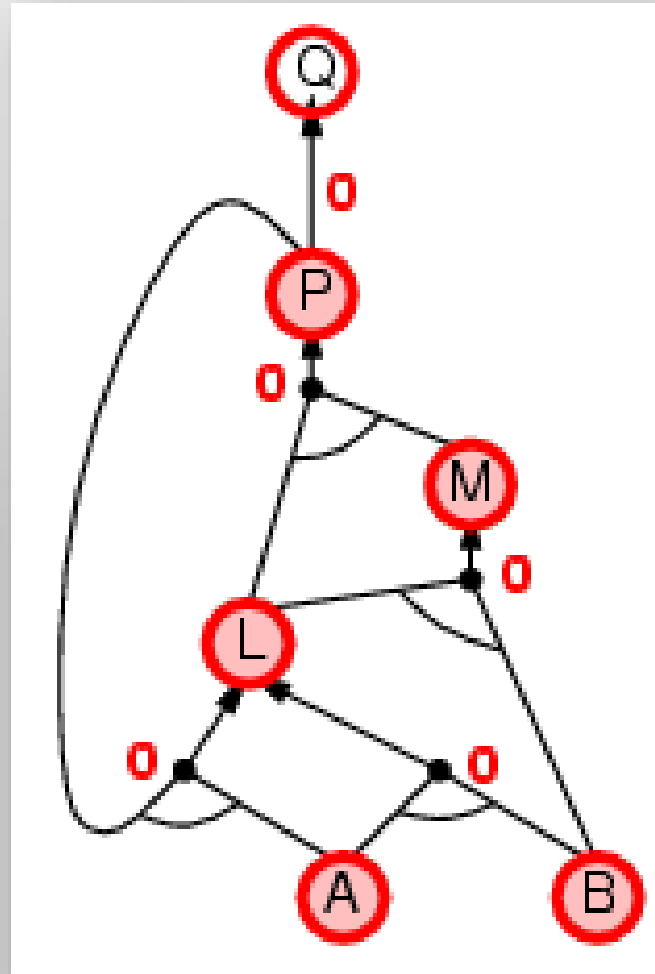
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Forward chaining

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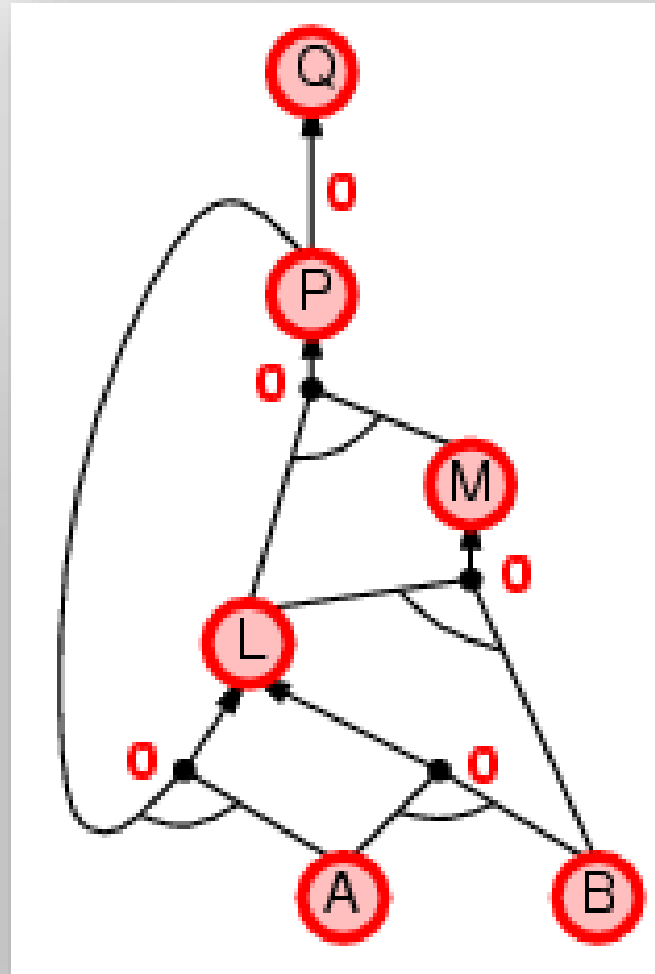
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A

B



Backward chaining

- Work backwards from query
- If query Q is true, no work has to be done
- Otherwise, algorithm finds implications that leads to Q
- If all conditions of one such implication can be proved true, then Q is true
- An example of goal driven reasoning

Backward chaining

$$P \Rightarrow Q$$

$$L \wedge M \Rightarrow P$$

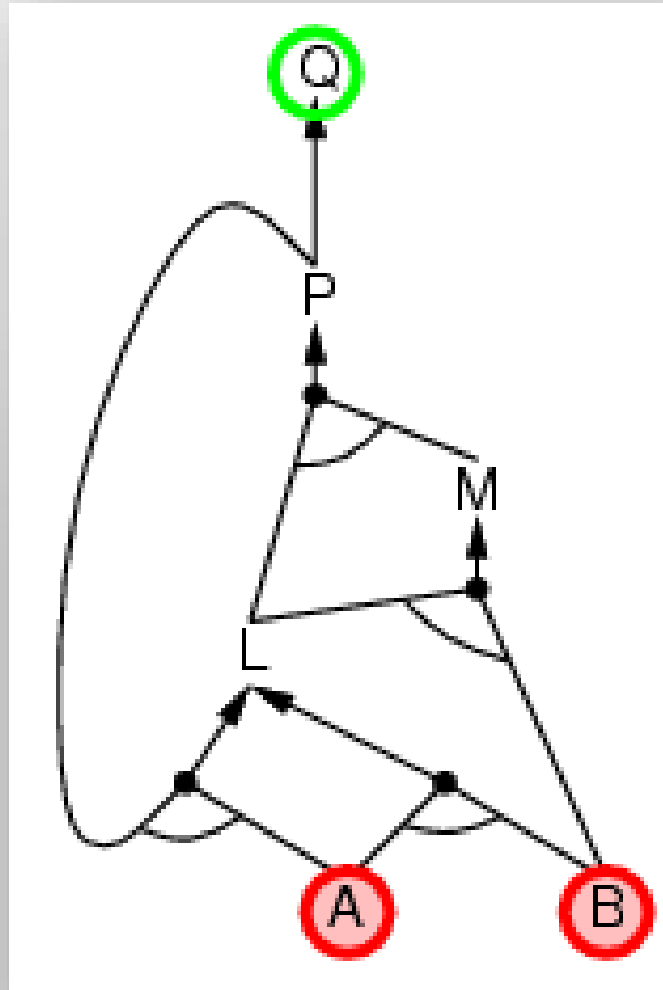
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Backward chaining

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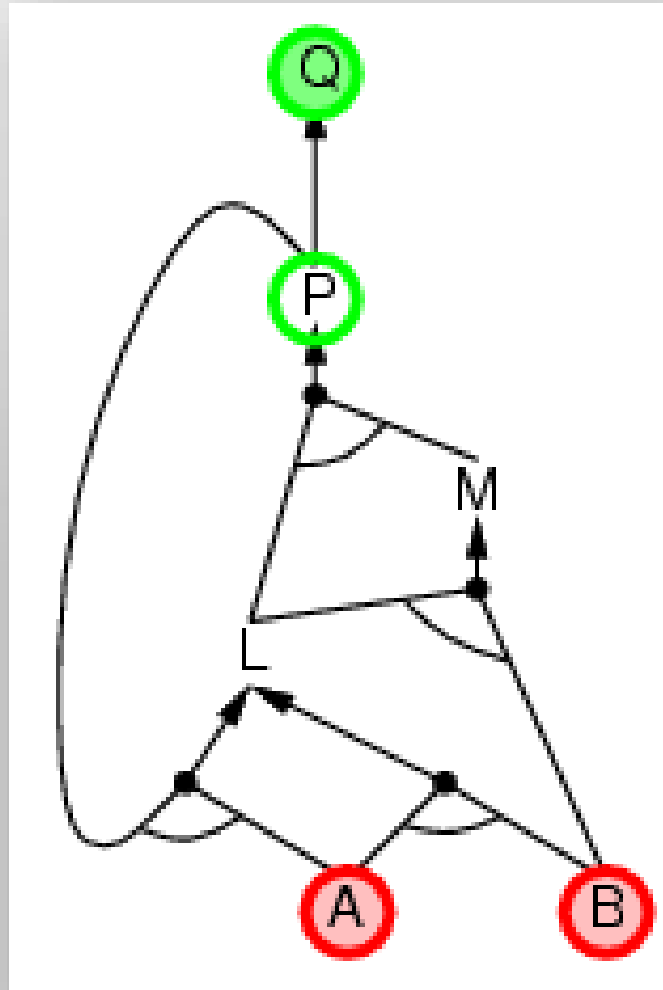
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Backward chaining

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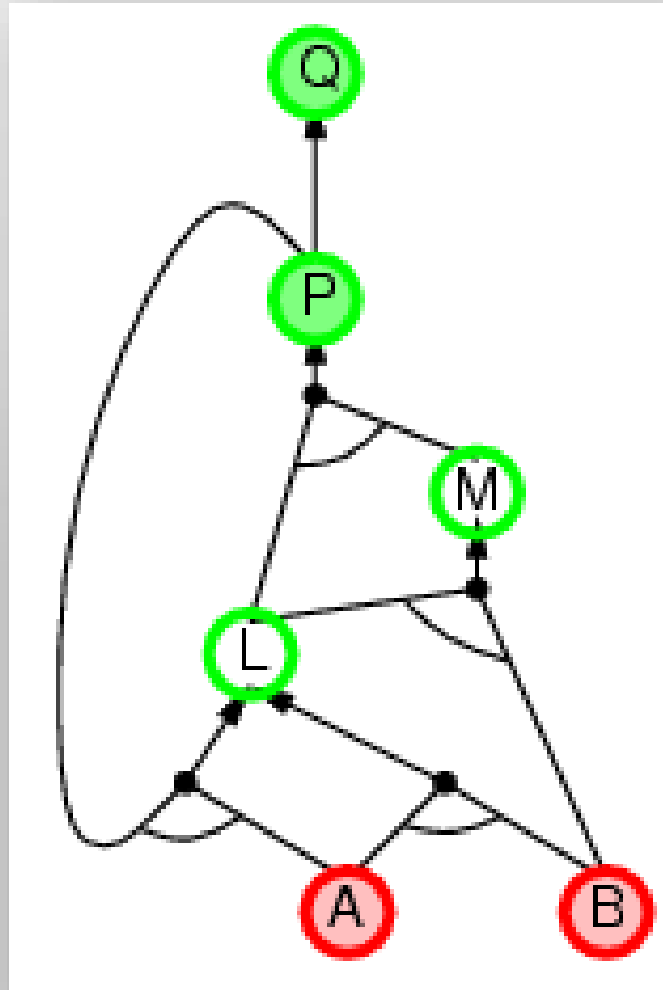
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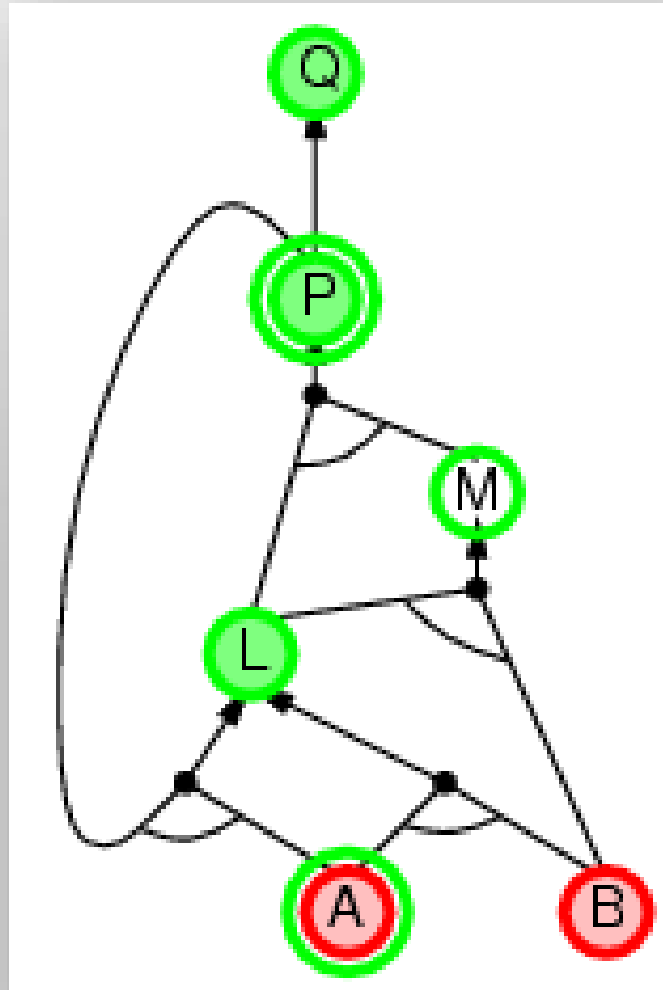
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Backward chaining

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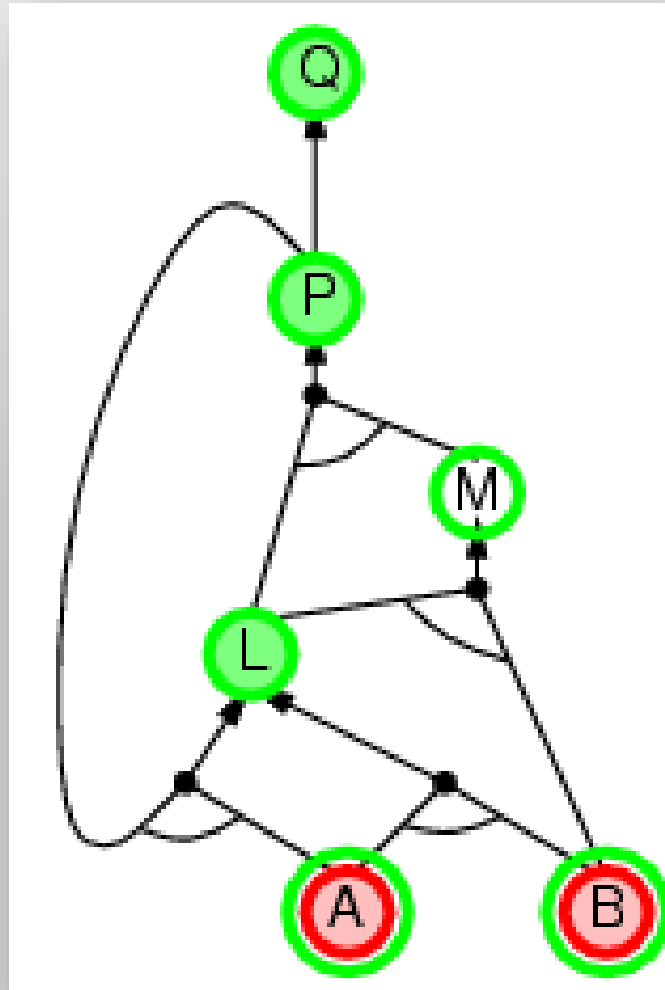
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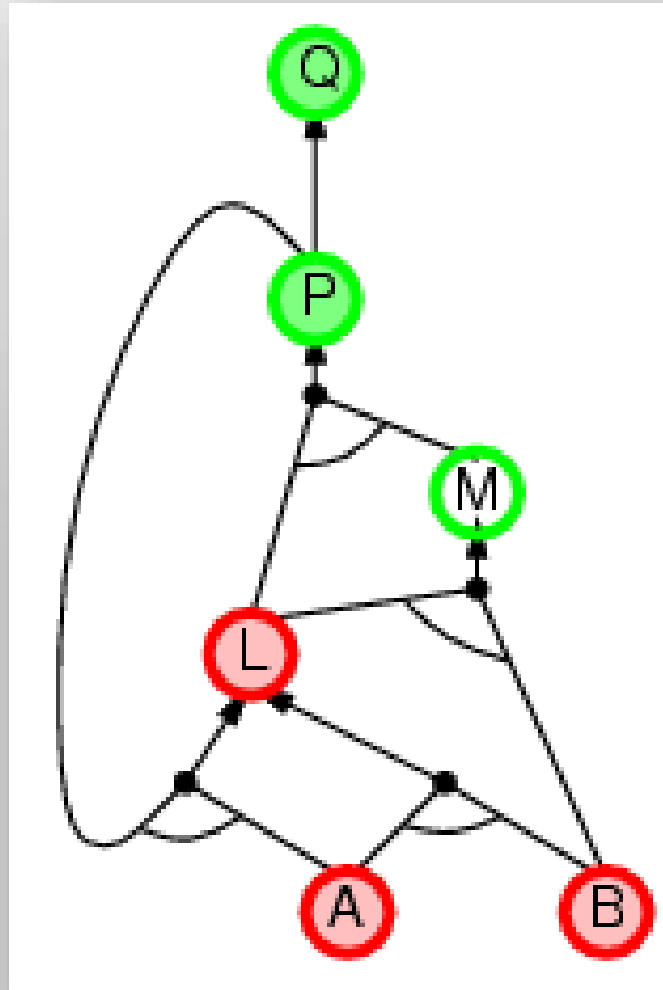
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Backward chaining

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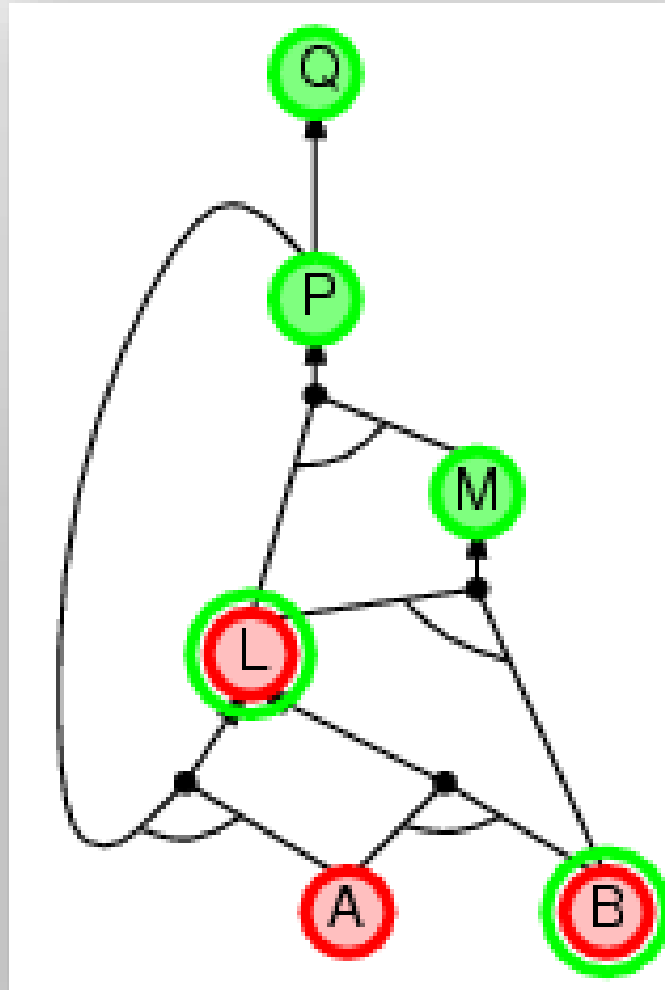
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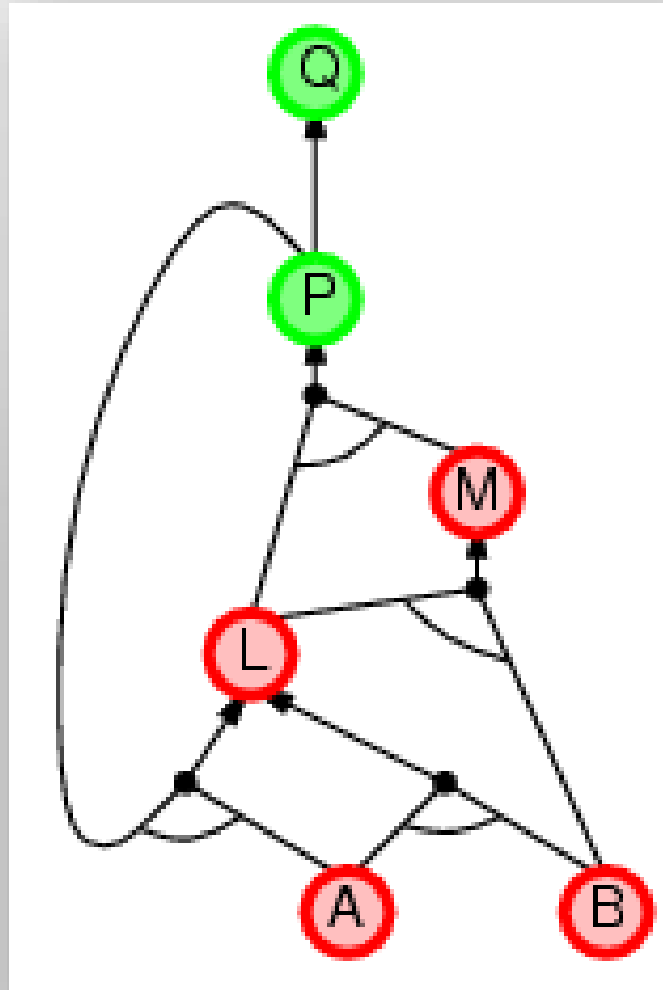
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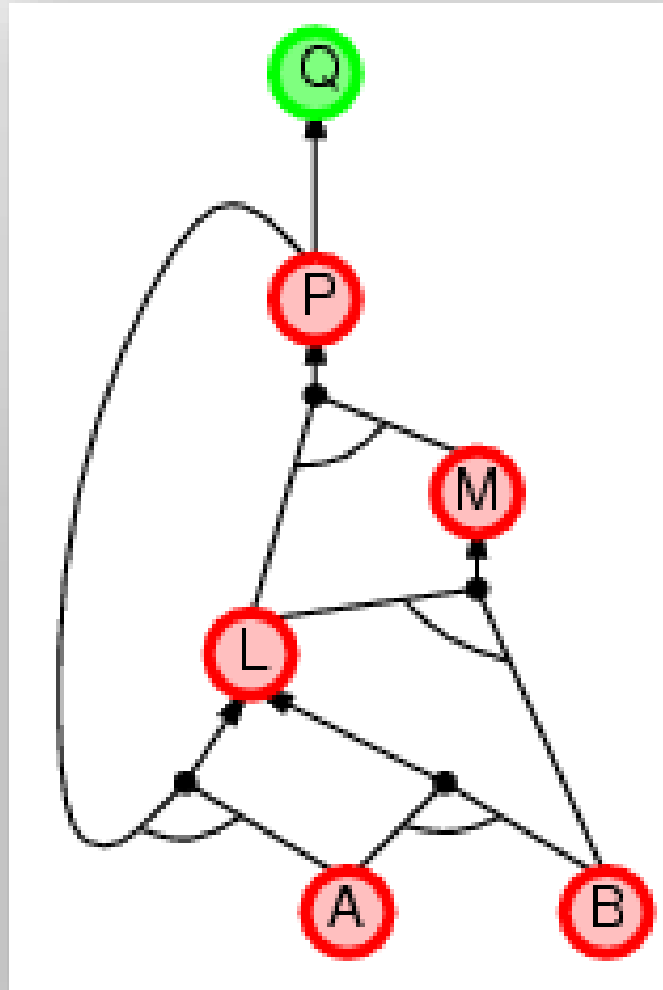
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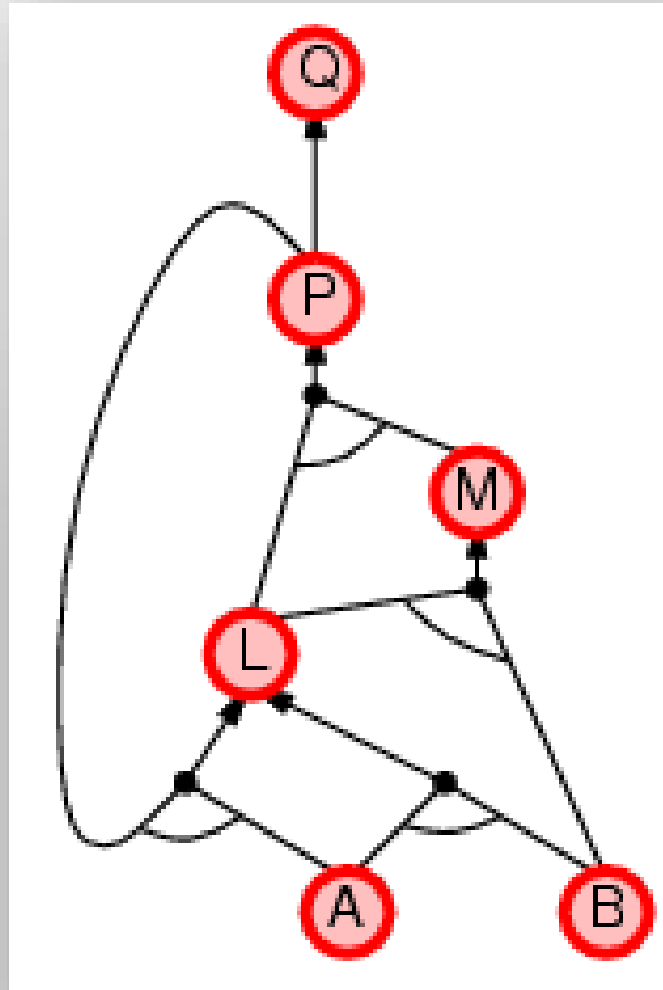
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A

B



Assignment



- Study today's work
 - Section 7.5.4
- Please do Practical assignment 3 for Wednesday, 15 September 2021
- Theory quiz 3 on today's work will be on Thursday, 16 September 2021